AN/APN-153(V)

DOPPLER NAVIGATION RADAR

GPL DIVISION

GENERAL PRECISION AEROSPACE

GENERAL PRECISION, INC.

PLEASANTVILLE, NEW YORK

Introducing GPL's

AN/APN-153 (V)

Doppler Navigation Radar

SELECTED BY THE U.S. NAVY for use in a number of their aircraft, the AN/APN-153 (V) is being produced in quantity and in accordance with Bureau of Naval Weapons Specification MIL-N-23407 (WEP). The AN/APN-153 (V) is GPL's new K_e Band 48-pound, 1-cubic-foot Doppler Radar Ground Speed and Drift Angle Sensor, which provides these functions as accurately as Doppler Radar systems weighing ten times as much.

The AN/APN-153 (V) is suitable as a self-contained navigation sensor in many types of military aircraft. By applying the latest value-engineering techniques, GPL has made available a high-performance system at low cost. The small size and low weight permit the system to be easily installed in any aircraft.

Its flexible design of digital and analog outputs provides excellent adaptability to all navigation systems and dependent sensors, including side-looking radars.

In its three units: Receiver-Transmitter, Control-Indicator, and Antenna Assembly, the AN/APN-153 (V) offers the best possible match of Doppler engineering to military requirements from the company that has built over 3,000 systems during the past 15 years.

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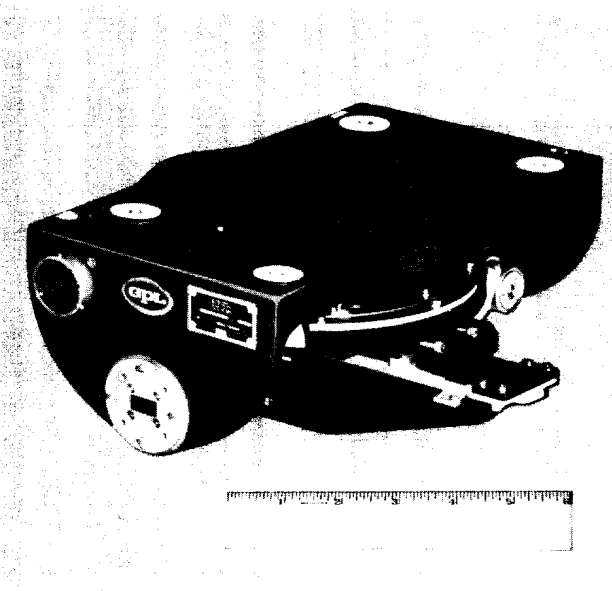
EQUIPMENT FEATURES

Smallest total system volume; only 1.04 cubic feet Smallest antenna for easy installation All electronics in a single unit; none on antenna Completely automatic acquisition; less than 20 seconds *No* altitude holes Output flexibility—analog and digital No external vertical information required, unless optional roll-stabilized antenna is used for special applications Transistorized; modular construction Built-in self-test function Simple, portable test equipment

OPERATIONAL FEATURES

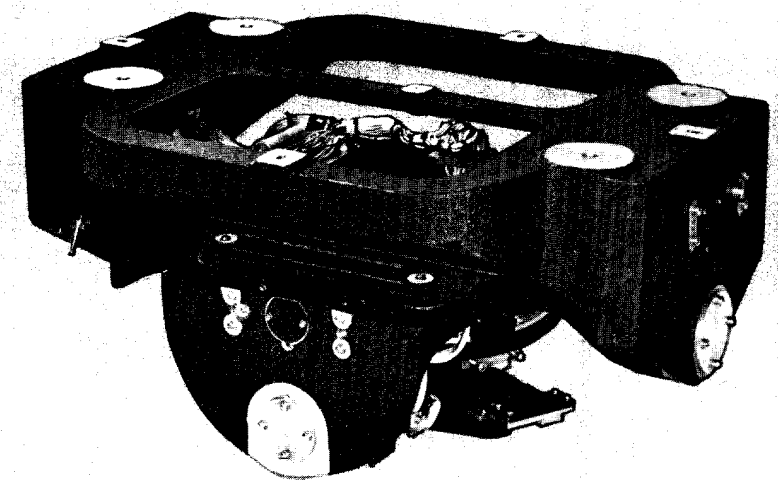
Accurate, over land, water or any other terrain Zero warmup time — instant readiness — flip the switch and GO No loss in accuracy with normal changes in aircraft attitude Provision for manual or automatic inputs of Ground Speed and Drift Angle if desired Outstanding roll performance and operation at all altitudes No recalibration is necessary when replacing any box, module, or subassembly Repairs can be performed at field or carrier shop level; no complicated supply-line or logistic requirements Operationally proven equipment. Completely flight-tested by the U.S. Navy in high-performance and ASW aircraft Complete system GO-NO-GO Test feature for flight line or air check (self-contained) Secure from Detection and Jam-proof as described in Airborne Instruments Laboratory Report AF 33 (616)-2483 (WADC) No. 3225-1

This is the **AN/APN-153(V)**



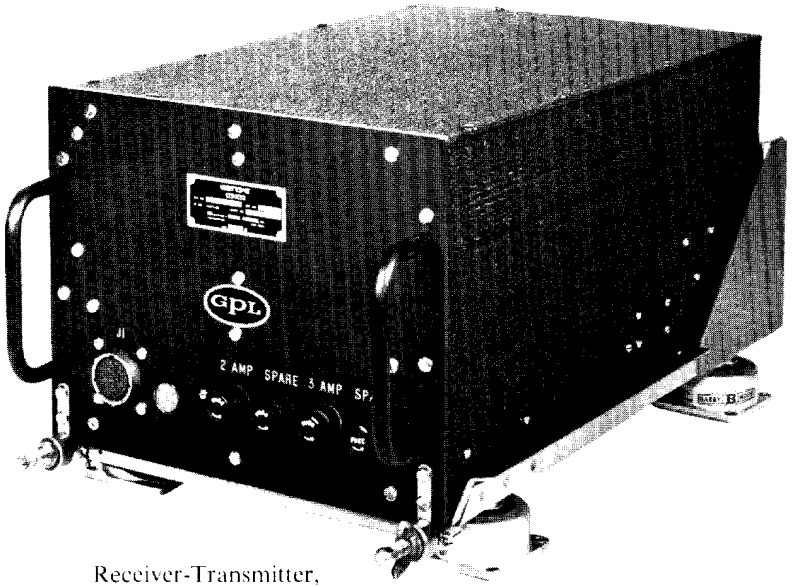
Antenna Assembly, AS-1349/APN-153 (V)

OR



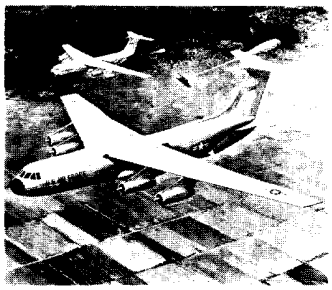
Antenna Assembly, Roll-Stabilized, AS-1350/APN-153 (V) for ASW and other applications during extended periods of operation at very large roll angles.

Control-Indicator, C-4418/APN-153 (V)

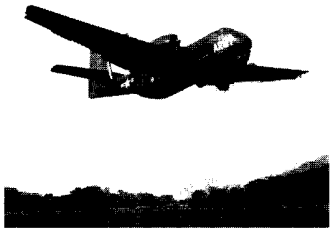


Receiver-Transmitter, Radar, RT-680/APN-153 (V)
with
Mount, MT-2840/APN-153 (V)

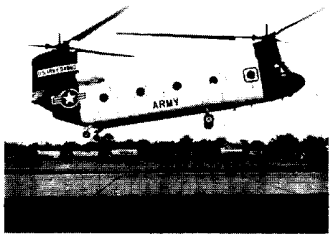
a few of the applications indicating flexibility and adaptability of the AN/APN-153 (V) for the following service missions



require dependable world-wide navigation over any terrain, including smooth seas, for long-range transport and air delivery missions.

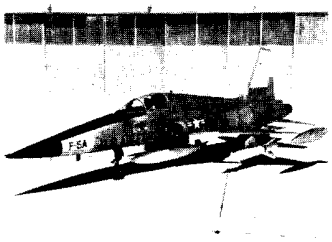


as currently being utilized for forward area and air-drop missions require pinpoint self-contained navigation accuracy which can be provided by the AN/APN-153(V).

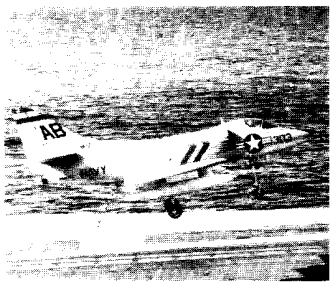


require accurate navigation for their combat support role.

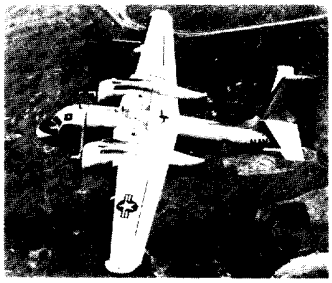
require precise navigation for surveillance and attack missions. Simplicity and ruggedness of the AN/APN-153(V) make it ideally suited for global front-line operation.



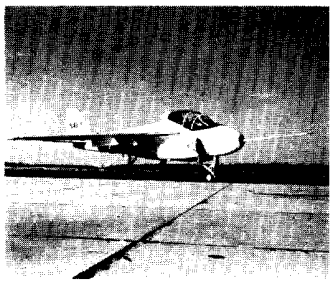
requirements for low cost, high-performance, reliability, and simple maintenance can be satisfied by the AN APN-153(V) system.



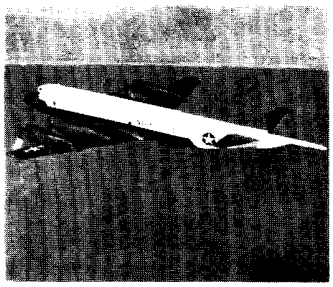
will use the AN/APN-153(V) for accurate navigation with minimum equipment weight for a variety of missions by the U.S. Navy and Marines at both high- and low-altitudes. Mission is similar to U.S. Air Force Fighter-Bomber aircraft.



perform both "hunter" and "killer" missions for fleet units. The AN/APN-153 (V) provides highly accurate navigation required for ASW missions, particularly under low-altitude, high-roll angle conditions for prolonged time periods.



use GPL Doppler for all-weather capability during attack mission profile. High- and low-altitude jet-powered planes can deliver nuclear punch or provide conventional close support for ground troops.

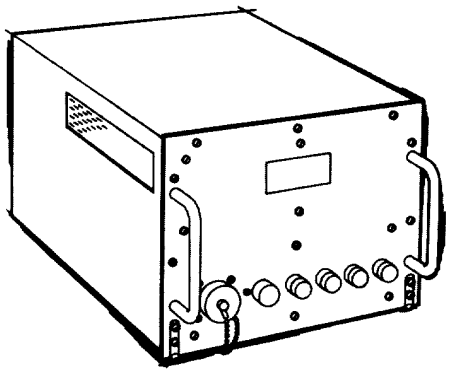


will use GPL Doppler for long-range search and attack missions. Again, as in the carrier-based ASW aircraft, these planes require extremely accurate navigation, particularly under low-altitude, high-roll angle conditions.

equipped with GPL Doppler provide the military with early-warning-of-attack and intercept-control. Aircraft will be able to remain airborne for long periods with accurate, self-contained, position-keeping capability.

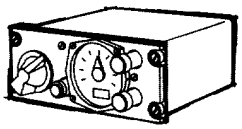
description of

is a velocity sensor giving accurate Ground Speed and Drift Angle. It is a transistorized, Janus-mixing, self-coherent K_e – Band Doppler Radar Set consisting of a Receiver-Transmitter, Control-Indicator, and Antenna Assembly. When exceptionally steep banks of long duration of over 60° are involved, GPL provides a Roll-Stabilized Antenna Assembly.

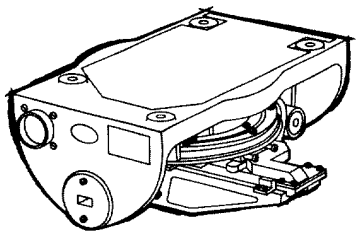


consists of the Radar Transmitter, Radar Receiver, Frequency Tracker, and detection and tracking logic. All elements have been incorporated into a single unit without sacrificing accessibility and ease of maintenance. The single package design has resulted in a saving of weight, greatly reduced cabling, fewer connectors, less power, and with much-increased reliability.

Construction is modular; all subassemblies and modules being removable with only a screwdriver and interchangeable without any recalibration. Thermal protection is provided. The unit contains its own cooling blower, although aircraft supplies may be used if preferred. All external connections are made through quick-disconnects. An elapsed-time meter is provided on the front panel.

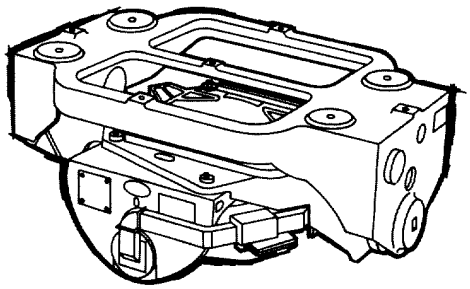


is designed for console mounting. The front face contains all the necessary controls and indications for operating the system as explained and shown on the opposite page. Drift Angle is displayed to 40° left or right, while Ground Speed is displayed on a counter—from 70 to 1,000 knots. (Can be supplied to meet the characteristics of both lower and higher speed range aircraft.) A lamp indicates when the system is in memory, and during this period, the last correct data is displayed and fed to any computer which may be used. The selector switch, in addition to OFF; includes STBY—in which all power except Magnetron high voltage is applied: ON—with both LAND and SEA positions, the latter being used to compensate for the difference in radar backscattering when flying over water for extended periods; and a spring-loaded TEST position which provides a quick GO-NO-GO check prior to or during flight.

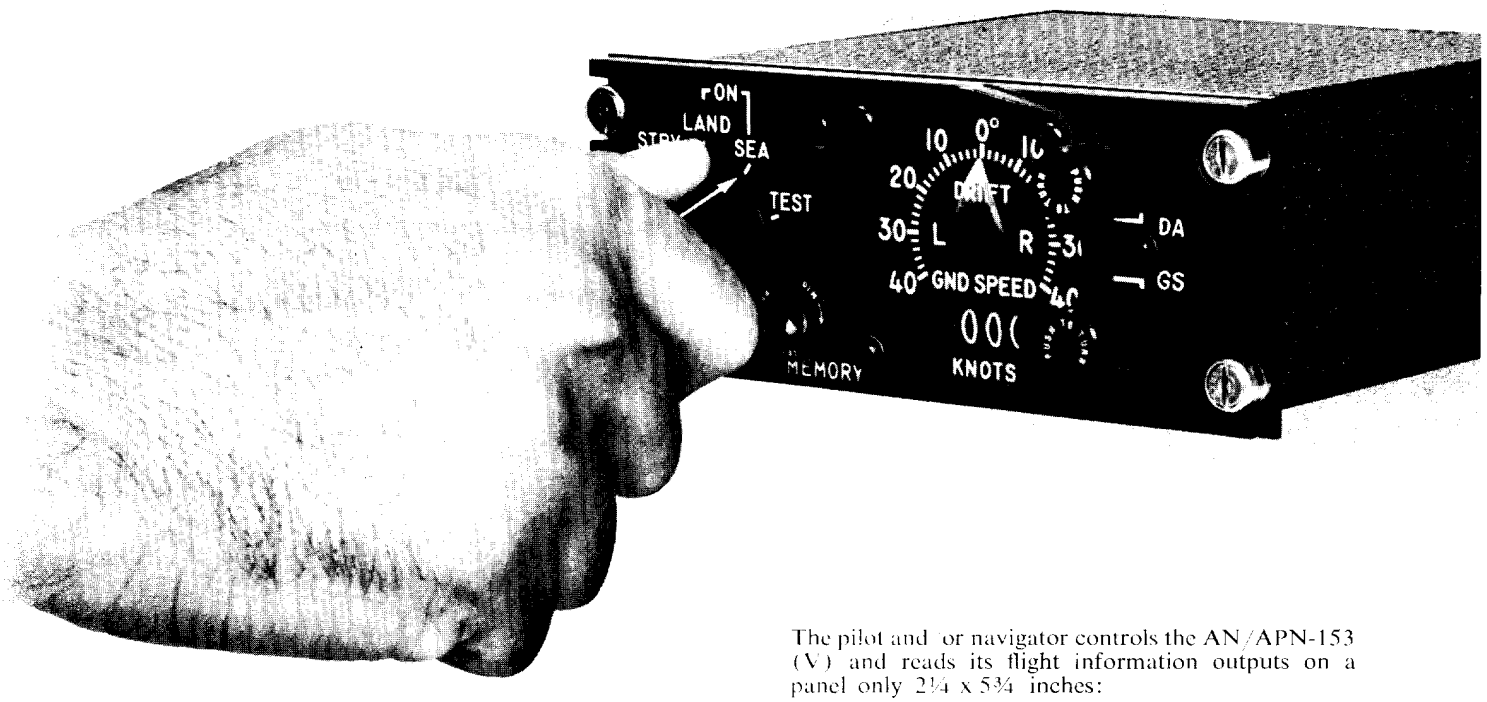


is a compact unit consisting of an antenna array and stabilizer. The stabilizer acts as a support for the arrays in addition to providing pitch and azimuth stabilization. A simple mercury switch controls a motor providing ±25° of pitch stabilization. No external attitude information is required. The Doppler signal controls azimuth stabilization for drift angles up to 40° left or right. No crystals or electronics are installed on the antenna. A quick-disconnect waveguide permits rapid removal or substitution; another antenna may be inserted *with no recalibration.*

OR



is the same as the above with the addition of an external roll gimbal, which provides up to 60° full mechanical stabilization. External pitch and roll information is used in lieu of the mercury switch.



The pilot and/or navigator controls the AN/APN-153 (V) and reads its flight information outputs on a panel only 2¼ x 5¾ inches.

Operation of

GPL's AN/APN-153(V)

is simple

With AN/APN-153 (V), warmup is unnecessary. Throw the switch to ON and, within 45 seconds, the system is presenting accurate Ground Speed and Drift Angle on its indicator and sending electrical analog or digital outputs of these quantities to navigation computers or other instruments.

For a quick system check, either before flight or in the air, place the switch in TEST. Within seconds, the memory light will go out, Ground Speed will drive to 500 knots, and Drift Angle will go to zero indicating system is "GO."

When flying over water for extended periods, turn the switch to SEA; the AN/APN-153 (V) will then recalibrate its computer to maintain the highest possible accuracy.

The STANDBY position holds the AN/APN-153 (V) ready for instant operation. When placed in ON from this position, a maximum of 20 seconds is required for correct Ground Speed and Drift Angle outputs.

This is the complete operating procedure.

AN/APN-153 (V) features OUTPUT VERSATILITY

One of the outstanding features of the AN/APN-153 (V) is the multiplicity and flexibility of outputs it can provide. These are detailed below and make this system compatible with analog and digital computers and other navigation aids.

OUTPUT	STANDARD	OPTIONAL
GROUND SPEED (V_g)	Synchro Output, 36°/100 knots. Requires 26 VAC excitation from associated equipment.	1. Synchro Outputs at scale factors different from the standard output. 2. Three-wire potentiometer or Vernistat output. Excitation supplied from dependent equipment. 3. A size 11 analog-to-digital converter may be used to give digital output.
DRIFT ANGLE (δ)	Synchro Output, 1°/1°. Requires 26 VAC excitation from associated equipment.	1. Synchro Outputs at scale factors different from the standard output. 2. A size 11 analog-to-digital converter may be used to give digital outputs. 3. Differential Synchro, 1°/1°. Requires heading input for Track Output.
ALONG HEADING VELOCITY (V_h)	Linear Output, 400cps at 30 millivolts/knot.	If Along Heading Velocity and Cross Heading Velocity are not required, a three-wire potentiometer or Vernistat output of Ground Speed; and any other Drift Angle or Track Output option may be obtained.
CROSS HEADING VELOCITY (V_d)	Linear Output, 400cps at 30 millivolts/knot.	

The AN/APN-153 (V) can be configured to provide pulse train outputs of:

Ground Speed

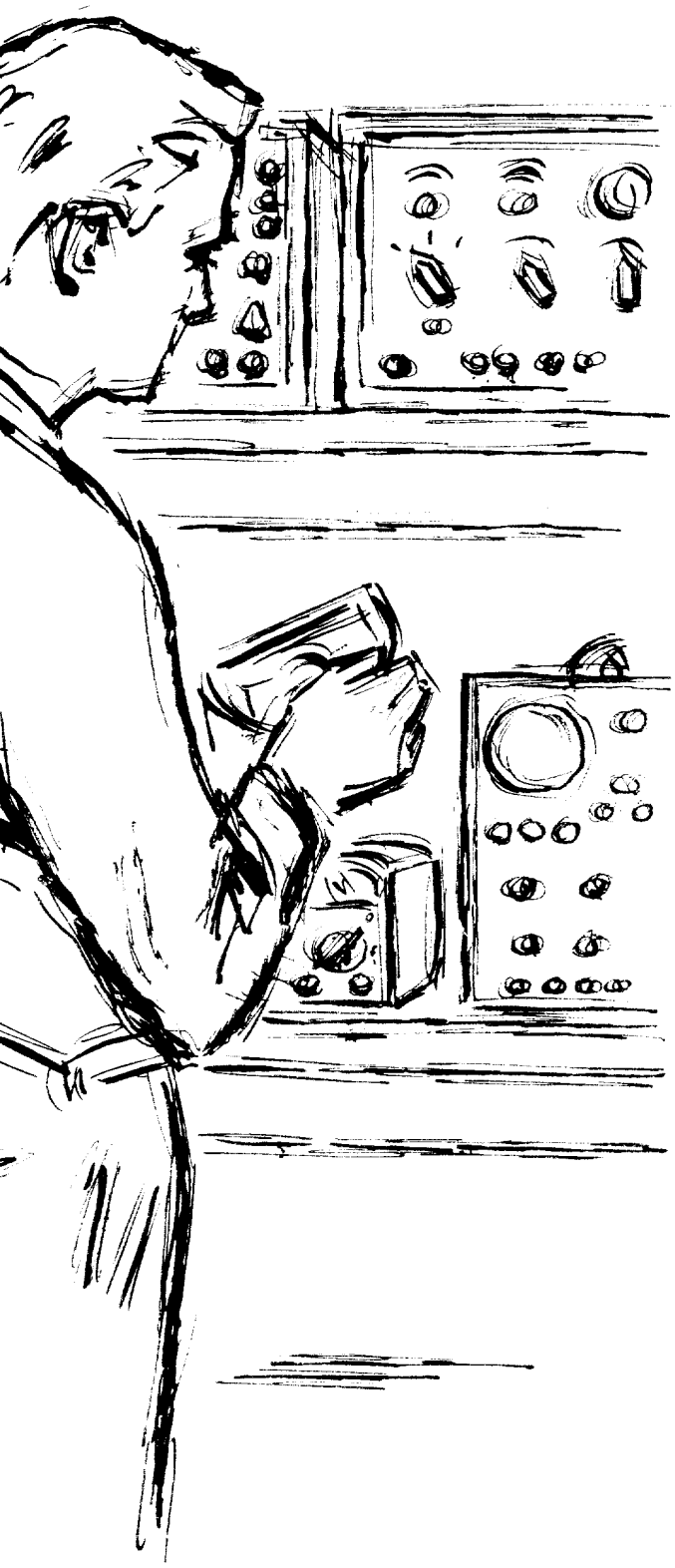
OR

Along Heading and Cross Heading Ground Velocities

OR

N-S and E-W Ground Velocities

These pulse train outputs can be provided at various scale factors to suit the application.



High reliability is achieved in the AN/APN-153 (V) by the use of printed-circuit boards and transistorization. All switching circuits, except primary power and overload protection, are solid state. Of the 189 transistors used, 130 are of one type.

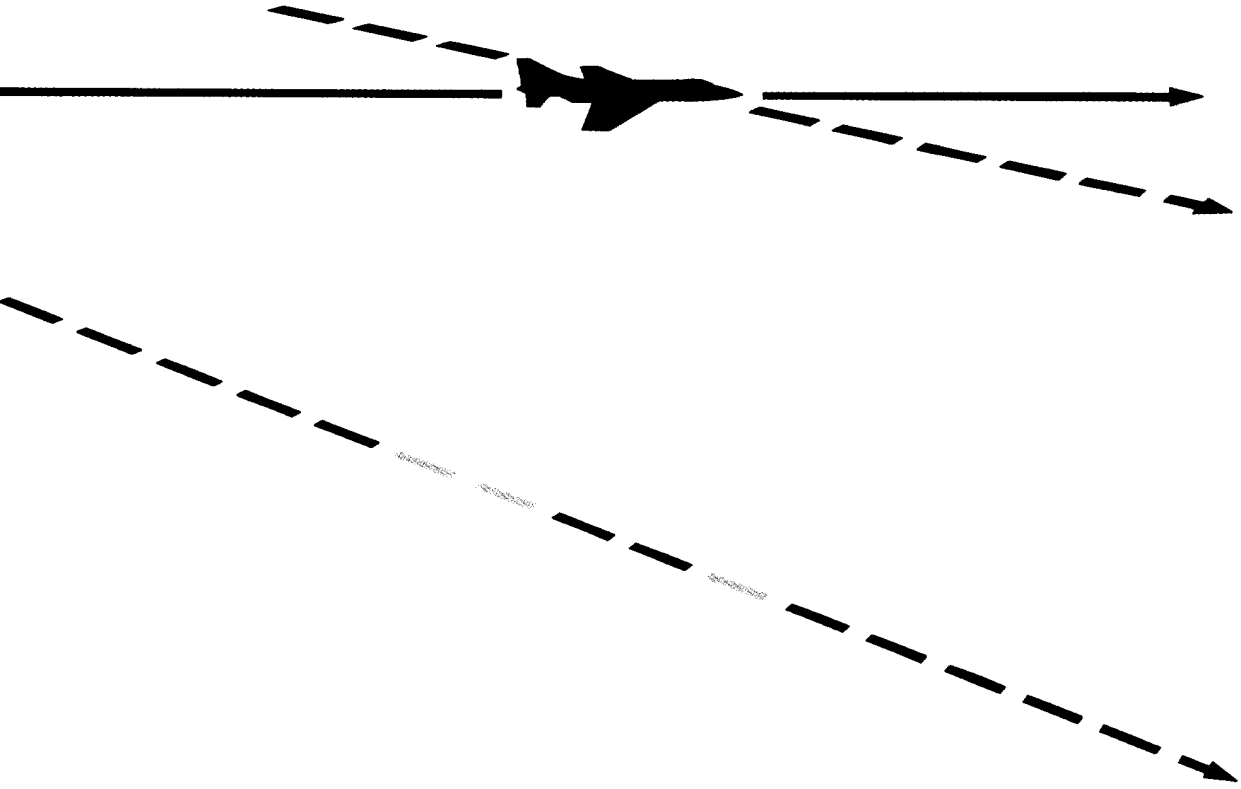
Flight line maintenance is facilitated by a built-in test circuit for GO-NO-GO test. Unit substitution is simple, since all electronics are in one unit.

Field maintenance and carrier shops require only a System Performance Test Set, bench harness, junction box, and a minimum of standard test equipment. These test units and the large number of convenient test points permit repairs down to module and component level by reasonably qualified service technicians.

All units and modules within units can be substituted without adjustment or recalibration of any other part of the equipment.

Light, portable test equipment permits 100% confidence check and repairs down to component level.

A 40-pound System Performance Test Set combines the functions of a Doppler Simulator Test Set and a portion of the microwave test equipment into a single portable unit. This set in addition to bench harness, junction box, and minimum standard test equipment provide complete maintenance of the AN/APN-153 (V).



how it works

The AN APN-153 (V) beams signals to the ground, receives echoes, and measures the frequency shift produced by the relative motion between aircraft and earth. (Since the aircraft moves both *along* its length and *across* its length, more than one beam is necessary; the AN APN-153 (V) uses four.)

As the figure shows, these four beams strike the ground at the corners of a rectangle. The system is pulsed so that only two beams (diagonally opposite) are transmitted and received at a time. Of these, aircraft motion shifts the forward beam *up* in frequency, the rearward, *down*. These two shifts are compared in the Doppler system, yielding a difference signal for one beam pair. The same is performed for the second diagonal pair.

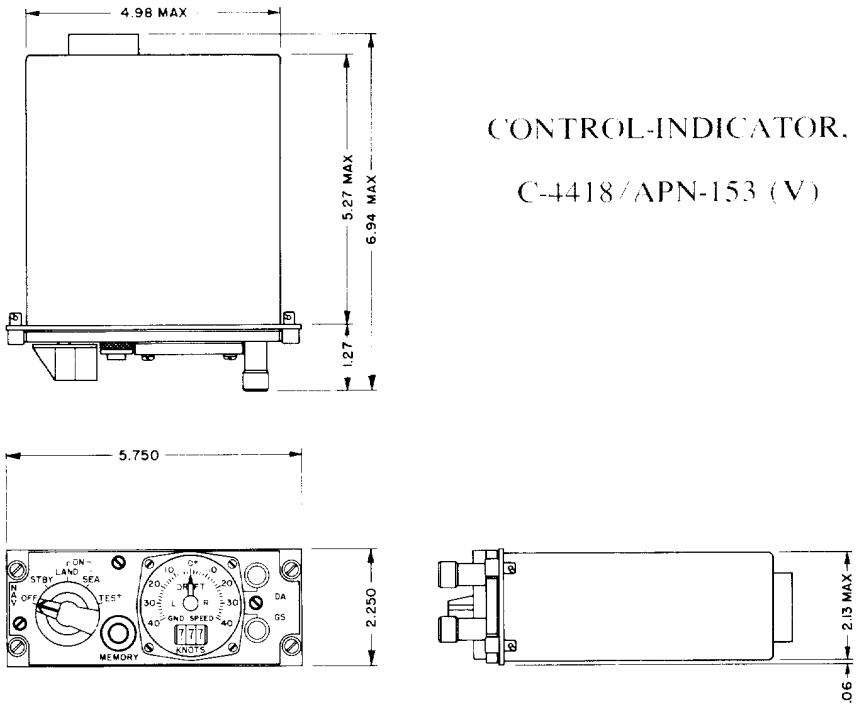
Now, these two *differences* are themselves compared and an azimuth motor rotates the antenna to make—and keep—them equal (which means that the antenna is aligned with aircraft track). This is a unique advantage of GPL Doppler: the antenna is always turned to keep these two differences equal and, since Drift Angle is derived directly from antenna position, Drift-Angle accuracy is never affected by signal quality, terrain, or sea state as long as any echo at all is received. And, once the antenna has been so positioned (which takes only a few seconds after power is applied) the system is also deriving precise Ground Speed.

performance data and characteristics

UNIT	SIZE (L x W x H)	WEIGHT	VOLUME
Receiver-Transmitter, Radar RT-680/APN-153 (V)	15-1/2" x 10-1/4" x 7-5/8" (standard 1 ATR medium)	35-1/2 lb.	0.70 cu. ft.
Control-Indicator C-4418/APN-153 (V)	5-1/4" x 5-3/4" x 2-1/4"	3-1/2 lb.	0.04 cu. ft.
Antenna Assembly AS-1349/APN-153 (V)	Static 10-1/2" x 12" x 4-15/16" Swept 10-1/2" x 12" x 6"	9-1/2 lb.	0.30 cu. ft.
Antenna Assembly, Roll-Stabilized AS-1350/APN-153 (V)	Static 18-1/8" x 12-3/4" x 8-1/8" Swept 18-1/8" x 13-5/8" x 13-5/16"	21-3/4 lb.	1.00 cu. ft.
Mount MT-2840/APN-153 (V)	20-3/16" x 11-3/16" x 6-3/4" (max. extended dimensions)	3-1/2 lb.	(Not Applicable)

	13.325 kmc. ± 30 mc.
(Standard):	
Ground Speed	Synchro 36°/100 knots
Drift Angle	Synchro 1°/1°
Along Heading Velocity	400cps at 30 millivolts/knot.
Cross Heading Velocity	400cps at 30 millivolts/knot.
(Probable):	
Ground Speed	0.17%
Drift Angle	0.17°
Along Heading Velocity	0.25%
Cross Heading Velocity	0.25%
These accuracies are achieved over the total performance range of speed, altitude and environment. For specific aircraft applications or missions, higher accuracies can be achieved. Consult GPL for details.	
	70-1000 knots (Can be supplied to meet the characteristics of both lower and higher speed range aircraft.)
	40° left or right
	40 to 70,000 feet.
	± 25 degrees (Self-contained pitch sensor)
	No external cooling air required up to 50,000 feet
	None required
	−54°C to +71°C (operating) −62°C to +95°C (non-operating)
	115 volts ±10%, 425VA, 380-420cps AC No DC required
	Not normally required Roll-stabilized model available for extended operation of aircraft in bank angles in excess of 60°

The AN/APN-153 (V) meets MIL-E-5400



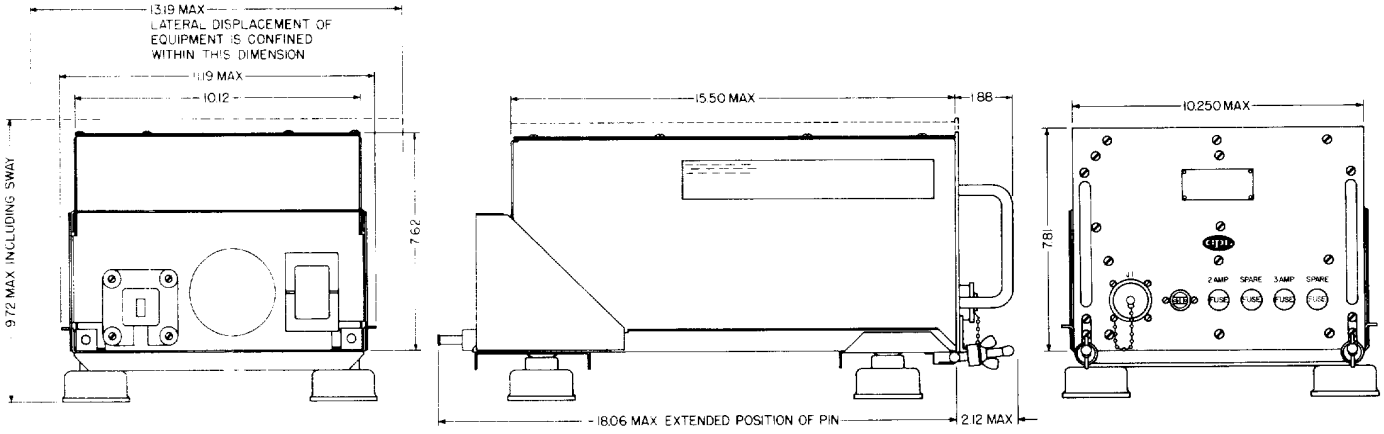
CONTROL-INDICATOR,

C-4418/APN-153 (V)

AN/APN-153 (V)
OUTLINE DRAWINGS

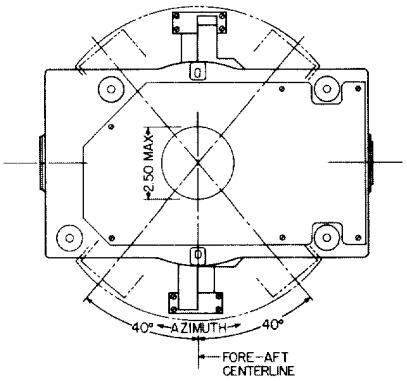
RECEIVER-TRANSMITTER, RADAR, RT-680/APN-153 (V)

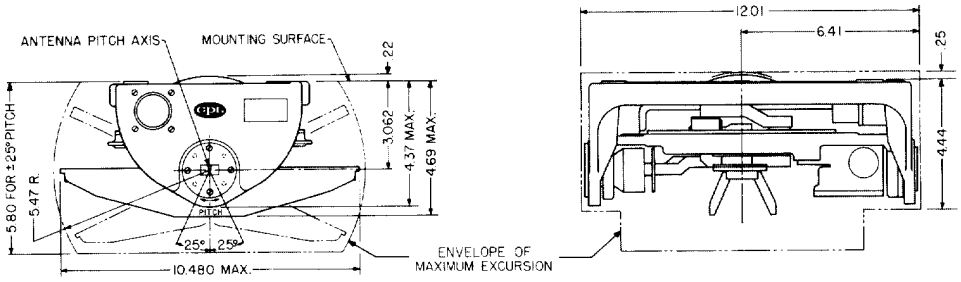
MOUNT, MT-2840/APN-153 (V)



ANTENNA ASSEMBLY,

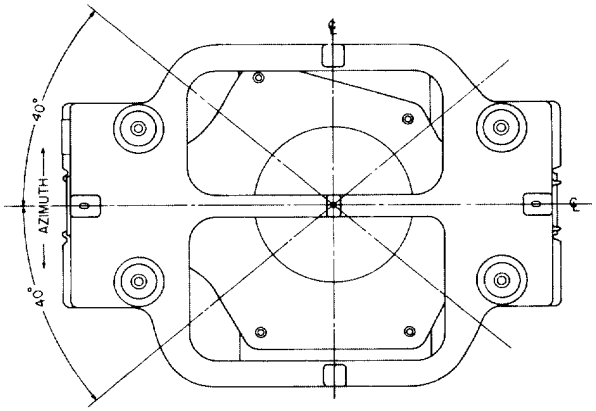
AS-1349/APN-153 (V)

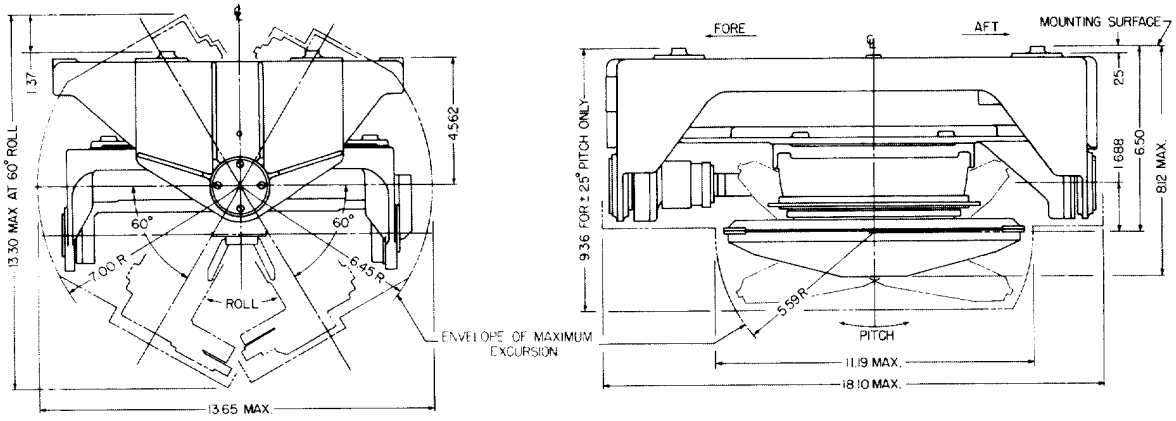




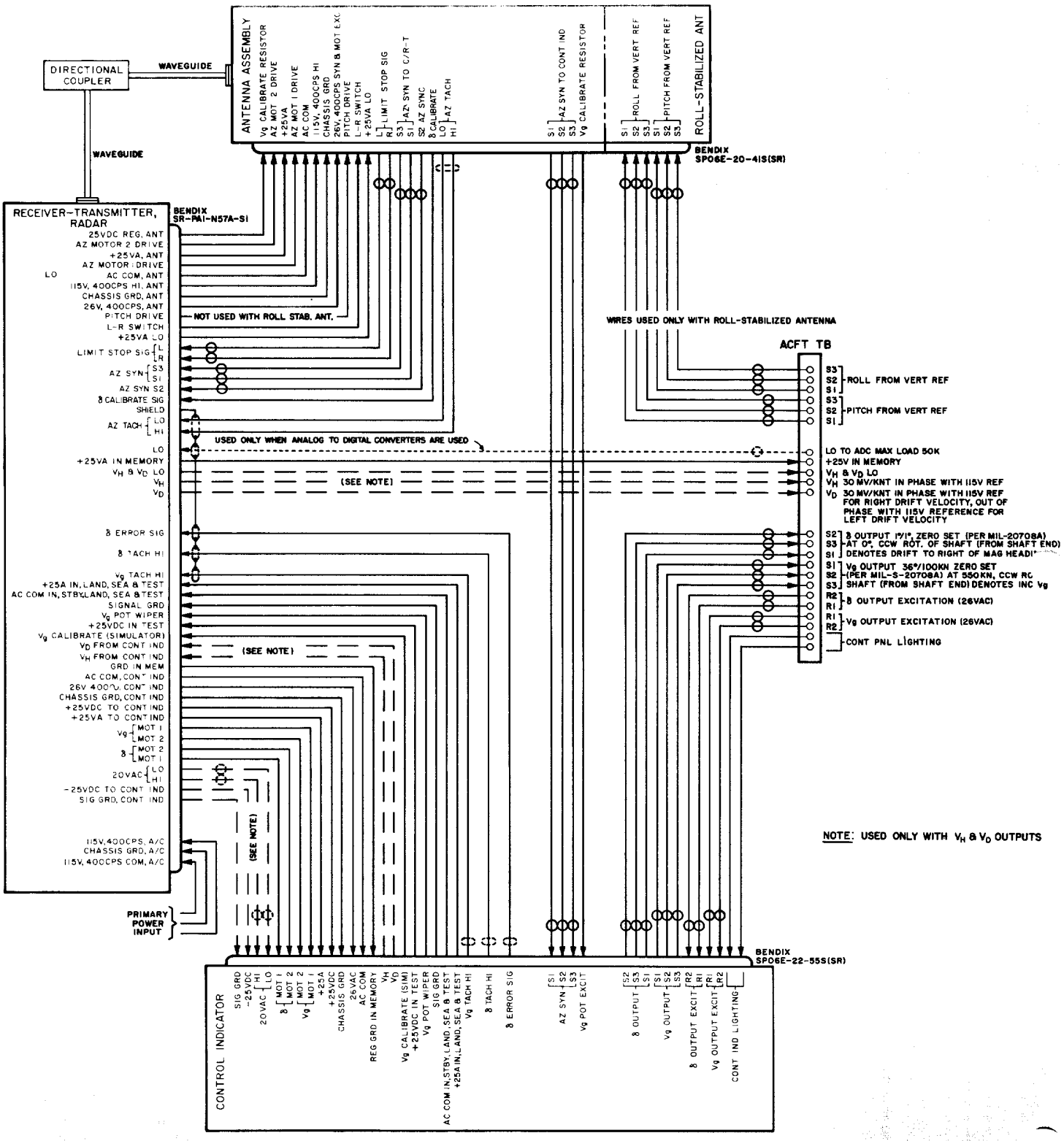
ANTENNA ASSEMBLY, ROLL-STABILIZED,

AS-1350/APN-153 (V)

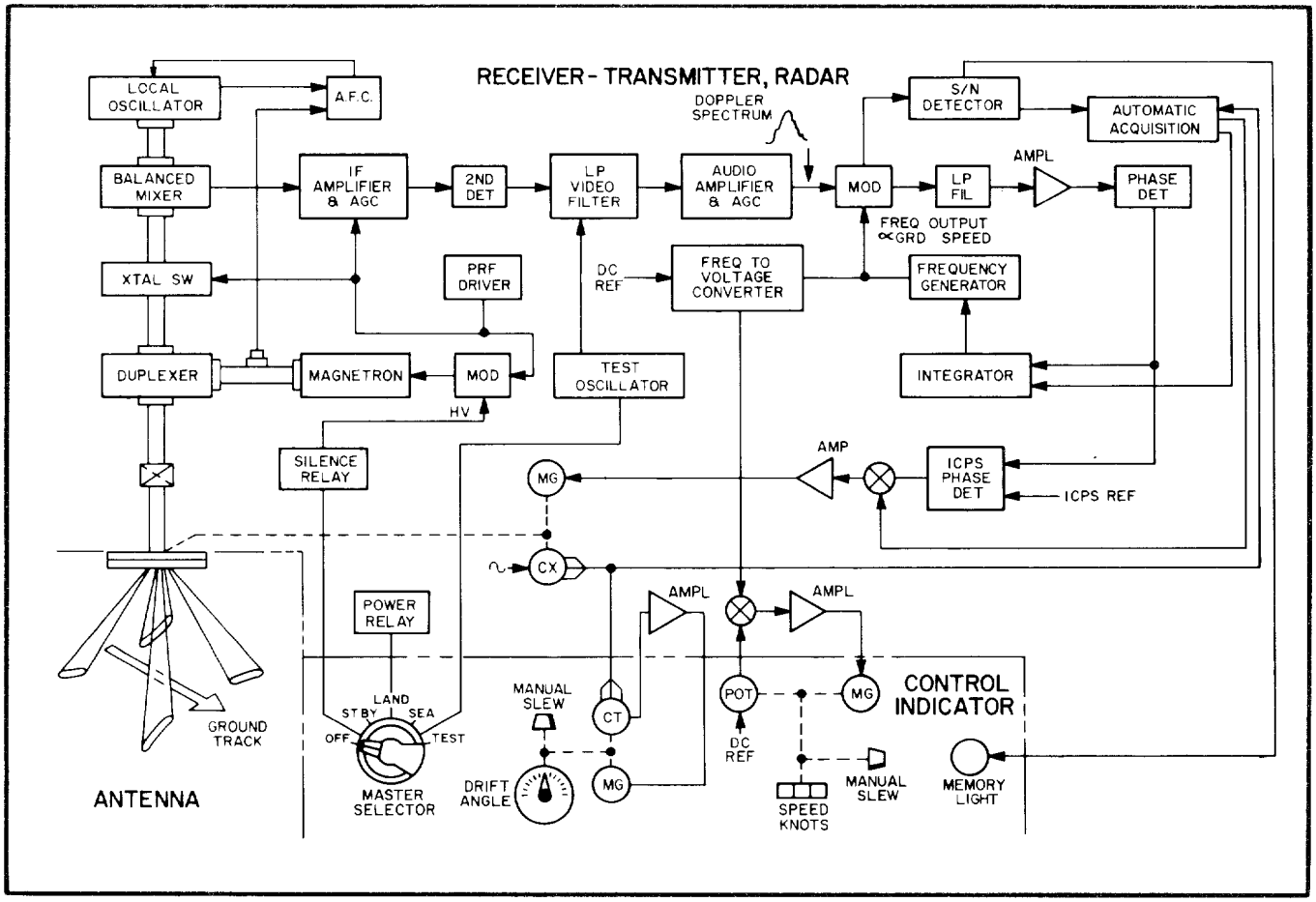




SYSTEM INTERCONNECTION WIRING DIAGRAM



AN/APN-153(V) FUNCTIONAL BLOCK DIAGRAM



The AN/APN-153 (V) Transmitter is essentially a conventional radar circuit using a Magnetron power oscillator whose PRF is varied by a sawtooth voltage.

The RF from the transmitter is fed to the Antenna where two radiation patterns are emitted alternately at half-second intervals. Each pattern consists of two lobes; one transmitted to the right-front and left-rear, the other to the left-front and right-rear of the aircraft. The R-F energy in these lobes strikes the ground at the corners of a rectangle. Thus, the echo returned from the ground always contains the reflection of both a front- and a rear-pointing lobe, the frequency of each being Doppler-shifted as a result of the aircraft motion.

The received echoes are fed to a microwave superheterodyne receiver and converted to I-F. The two signals are then amplified in the I-F amplifier, mixed, and detected. They appear at the output of the detector as a single audio signal. This audio signal is filtered, amplified, and fed to the Frequency Tracker. Here, the audio is mixed with the output of a frequency generator in the Main Tracking loop. Any difference signal produced is amplified in the Main Tracking loop and phase detected; the resulting voltage, through an integrator, controls the frequency generator, making its frequency equal to that of the audio and proportional to Ground Speed.

The Cycle Counter develops a voltage proportional to the frequency of the frequency generator, and through a servo, sets the position of the Ground-Speed counter in the Indicator as well as a synchro shaft position for remote computer operation.

In the Main Tracking Loop, the two audio signals derived from the alternating patterns are compared. Any difference between these signals produces an error signal in the detector of the Main Tracking Loop. This signal is fed to the Antenna Azimuth Servo which positions the arrays parallel to the aircraft's track. The array position, which now represents aircraft drift angle, is repeated by a follow-up servo in the Control-Indicator.

Automatic acquisition: a S/N Detector monitors the Main Tracking Loop for the presence of audio signals. Should audio from both patterns be absent simultaneously, the Memory Light illuminates on the Indicator, and the Ground-Speed and Drift-Angle shafts are locked at the last correct readings. The frequency generator is then swept downward through its range until a useable audio Doppler signal appears from one of the antenna beam patterns. The antenna then automatically slews in the direction of decreasing Drift Angle error until audio is acquired from the other pattern. At this time, the Drift Angle and Ground Speed shafts are unlocked and the Indicator begins its display. Normal signal tracking processes, as described in the previous paragraphs, are then initiated to refine the system outputs.

Provision for manual inputs of Ground Speed and Drift Angle during periods of Doppler silence is effected by means of knobs on the Control-Indicator. When the function switch is placed in the STBY position, all power except Magnetron high voltage is applied.

for technical advice or sales information, contact:

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MILITARY and GOVERNMENT APPLICATIONS

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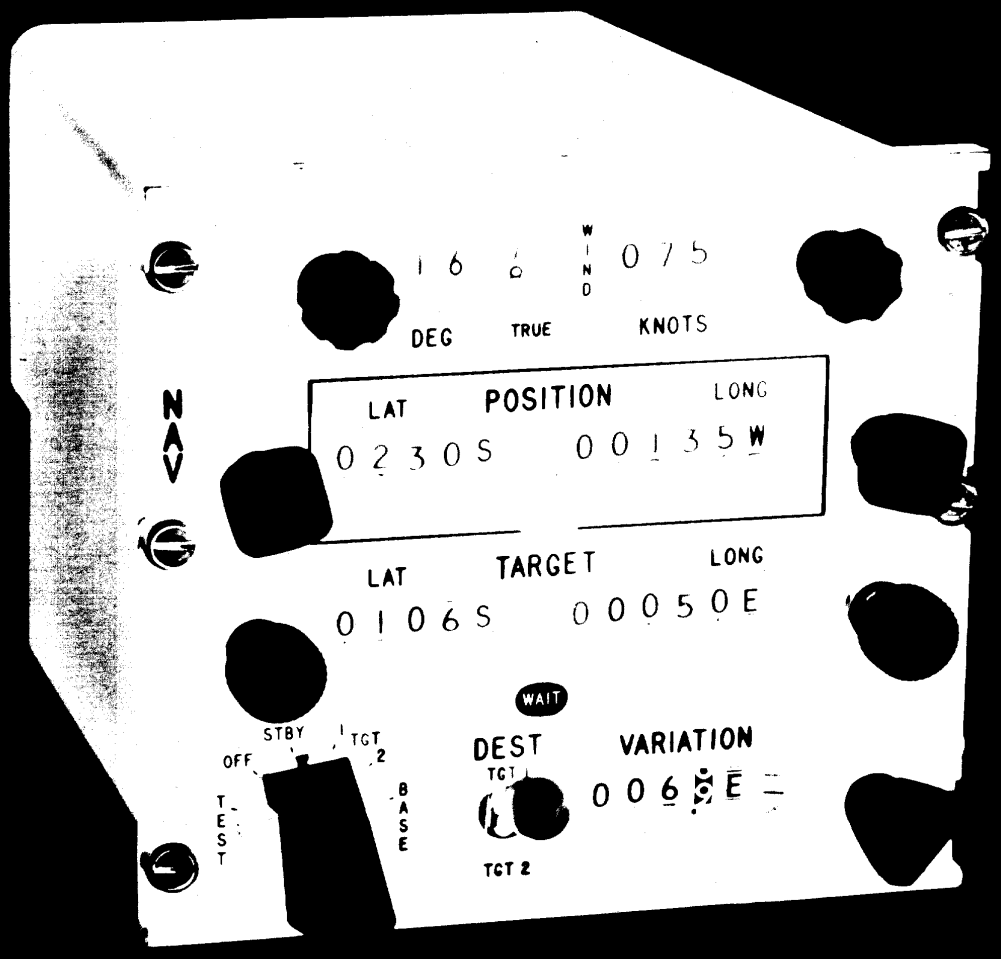
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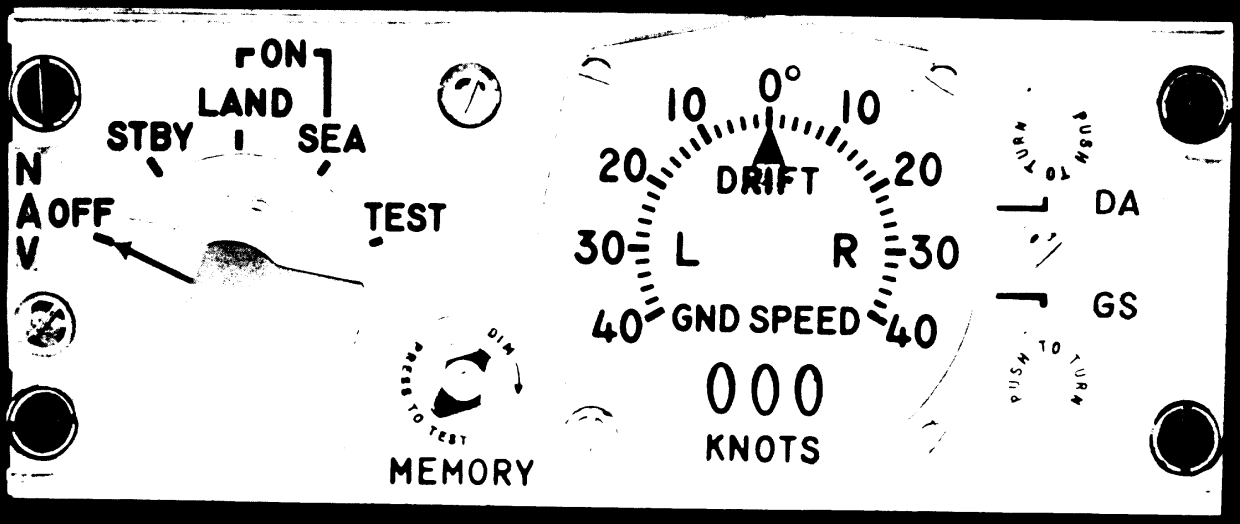
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